UNIT C

Disease Defence and Human Health

Today in Canada you can expect to live longer than your great-grandparents. This was not always the case. In the past, many people died from widespread outbreaks of disease. What causes disease? How does disease spread? How does the body protect itself from disease? How do the characteristics you inherit from your parents affect your health? How does the environment influence health?

For centuries, scientists have searched for answers to all of these questions. They discovered that disease-causing agents spread disease. In this unit you will learn about disease-carrying agents such as *Giardia*, which is present in water.

Today, antibiotics treat many diseases successfully. Research about how characteristics are passed from parent to child helps us better understand inherited diseases.

In this unit you will learn about all of these things, and about how public health helps to keep us all healthier than our great-grandparents. Knowledge about these topics can benefit your life in many ways.

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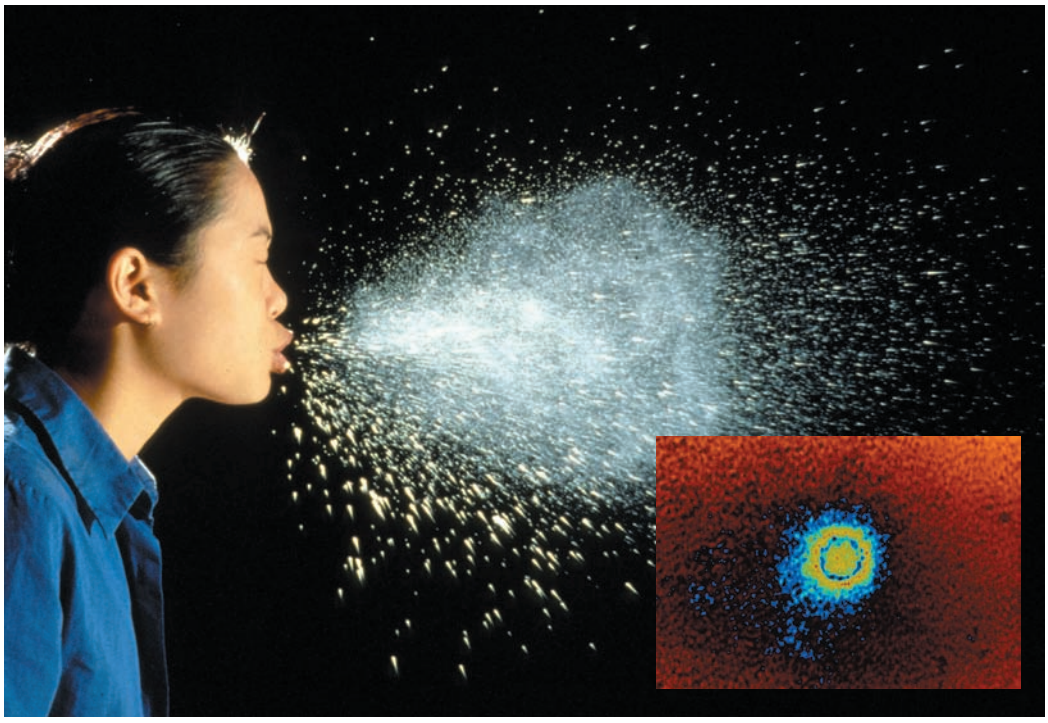
CHAPTER 9

Disease

Getting Ready...

- What causes disease?
- What can you do to avoid getting a cold?
- How might your lifestyle incease your risk for disease?
- How can you prevent food poisoning?



Science Log

Make a list of ways you protect food from spoiling. As you read this chapter, you will find out whether you handle foods safely. Make changes to your list based on what you learn. Put these new methods into practice.

Your head is throbbing. Your throat is so raw that it hurts to talk. You start to cough.

Before you cough again, consider your actions. The germs that cause colds are so small that you need a microscope to see them. But every time you cough without covering your mouth, you are sharing germs with others nearby.

Disease-causing agents such as cold viruses are all around you. In this chapter, you will investigate the conditions that allow these agents to grow and spread. You will learn about other causes of disease and about the differences between diseases spread by germs and those that are not caused or spread in this way. You will also find out how lifestyle, diet, and environmental factors such as lack of cleanliness play a role in disease. As you investigate ways to prevent the contamination of food, you will also learn about techniques used to destroy bacteria that contaminate food.

As you understand more about disease, you will see *why* you need to protect yourself from disease — and how to do it. In addition, you will understand how important your personal actions are the next time you start to sneeze!

What You Will Learn

In this chapter you will learn:

- what causes human disease
- how disease spreads
- the difference between communicable and non-communicable diseases
- how to handle food safely
- about techniques used to kill germs

Why It Is Important

- Every year, many people get sick or die from diseases that could have been prevented. Knowing about the causes and spread of disease can help you make better decisions about taking care of your health.

Skills You Will Use

In this chapter you will:

- identify causes of disease
- distinguish between communicable and non-communicable diseases
- investigate techniques used to prevent food contamination
- assess the impact of techniques used to kill germs

Starting Point ACTIVITY

Spreading Microbes

Food and water may be contaminated by disease-causing agents such bacteria or viruses. In this activity, you will investigate how these germs can be spread.

Safety Precautions

- Do not drink any liquids. They are toxic and can cause burns.
- Do not spill any chemicals on your hands or clothing.
- Clean up the work area and wash your hands thoroughly at the end of the activity.

What You Need

3 unknown solutions
4 medicine droppers
test tube
test tube holder
germ indicator solution

What to Do

1. Gather the materials for this activity and return them to your work station.
2. Draw a data collection chart similar to the one shown below.

Unknown Solutions	Colour Before Germ Indicator	Colour After Germ Indicator
#1 and #2		
#1 and #3		
#2 and #3		

3. Add one medicine dropper of solution #1 and one medicine dropper of solution #2 to the empty test tube. Record the colour of the solution.
4. Add one medicine dropper of germ indicator to the test tube. Record the colour.
5. Clean out the test tube.
6. Repeat steps 3 to 5 for the combinations shown in the chart.

9.1 Causes of Human Disease

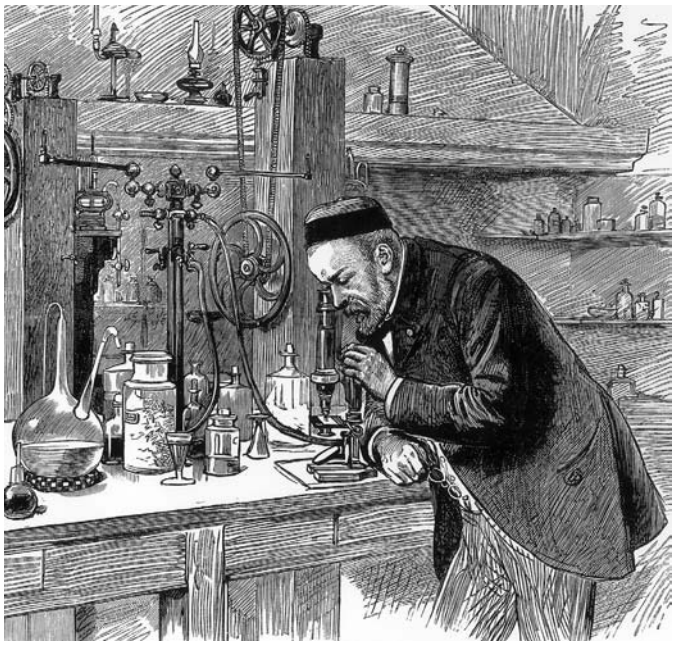


Figure 9.1 In the 1800s, French winemakers were upset because their wine kept turning to vinegar. Louis Pasteur discovered that a microbe was causing the spoilage. He heated the grape juice to kill the microbes. This technique is still used today and is called **pasteurization**.

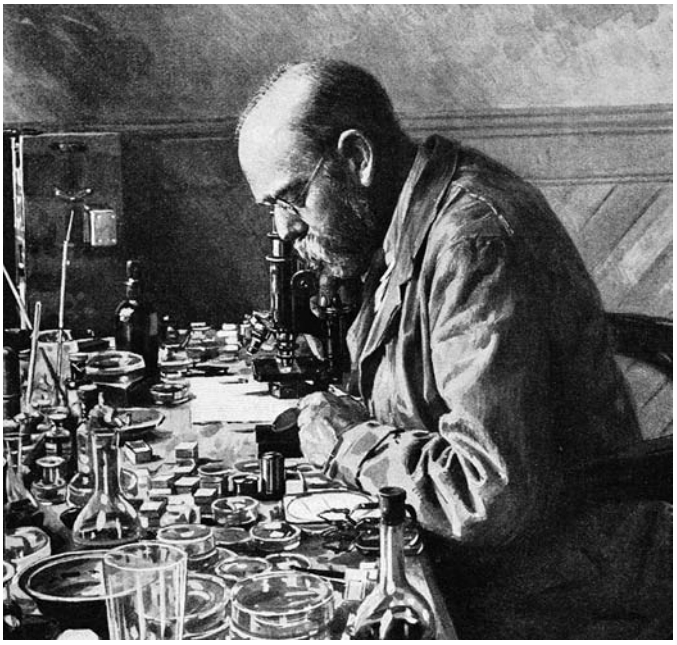


Figure 9.2 Robert Koch identified the pathogen that causes anthrax. He discovered that a pathogen could spread from a sick person to a healthy person.

Why do people get sick? In the past, people thought diseases were caused by various spirits or gods. Some people still hold these ideas. Scientists have another theory.

Disease, or illness, prevents the normal functioning of the body. As a result of the invention of the microscope, scientists like Louis Pasteur and Robert Koch found and identified micro-organisms known as **microbes**. The microbes that cause disease are called **pathogens** or germs.

Pathogens are not the only things that cause disease. Some diseases are caused by a poor environment. For example, air pollution can damage the lungs. People who live in a polluted area may develop lung disease.

Other diseases are genetic; for example, muscular dystrophy. This disease causes progressive weakness of the muscles.

Disease may also arise from a combination of factors that include the environment, diet, lifestyle, genetics, pathogens, and stress. For example, have you ever noticed how often you get sick when you are worried about a relationship? Often, when people are stressed, they eat poorly and may stop exercising. The diet and lifestyle choices they make combine with stress to make them more likely to get sick.

Pathogens live in toilets, air conditioners, and dirty wash cloths. If these are not cleaned regularly, the number of pathogens may increase. Indoor and outdoor pollutants can affect your health to a greater or lesser degree, depending on the type and amount of pollutants and your sensitivity to them. Some people may not experience health reactions from certain pathogens, while others do.

READING Check

Identify five factors that may interact with one another and possibly make you sick.

Pathogens

Pathogens are disease-causing microbes. Most pathogens are microscopic. These include some bacteria, viruses, fungi, and protists.

Bacteria

Bacteria are on your skin, in your mouth, in the air you breathe, and in the food you eat. Why can't you see them? Because they are single-celled organisms so small that you need a microscope to see one.

Some bacteria are beneficial to humans. Yogurt, for example, is made from milk and a bacterium that causes milk to go sour. You will find out how in Investigation 9–A.

Other bacteria are harmful to humans. They cause disease and spoil food.

Both the harmful and helpful kinds of bacteria reproduce quickly and form colonies when conditions are good. The box below shows the type of environment bacteria like.

1. **Temperature** — Most bacteria are active at warm temperatures. Refrigeration or freezing slows bacterial growth. Bacteria die when temperatures get too high.

2. **Moisture** — Bacteria need water. Many cannot reproduce without it.

3. **Food** — Bacteria thrive on sugar, protein, or fats.

Viruses

Like bacteria, viruses can be found anywhere there are cells to infect — and you are made of *trillions* of such cells.

Viruses, such as the common cold virus, are much smaller than bacteria. They reproduce by taking over cells in the body. Viruses use the part of the body cell usually used to reproduce cells. In this way, the number of viruses quickly multiplies, and they invade other body cells.

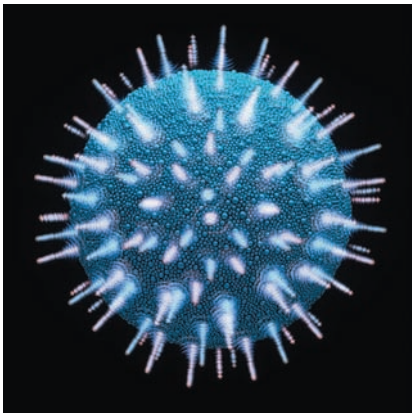


Figure 9.4 The HIV virus that causes AIDS looks like a bomb. It is a virus that flows through the bloodstream of infected individuals. An infected person may contaminate the blood of an uninfected person in one of several ways. These include:
- having sexual intercourse
- sharing intravenous needles
- receiving a transfusion of infected blood
- moving through the birth canal of an infected mother

DidYouKnow?

Gingivitis is one of the most common diseases in the world. It is an inflammation of the gums caused by bacterial plaque, a sticky, clear film that forms constantly on your teeth. Brushing and flossing daily is the best way to combat gum disease.

Figure 9.3

READING Check

List the conditions that bacteria need to grow. Explain why each is important.

CONDUCT AN

INVESTIGATION 9–A

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Conditions for Growth of Bacteria

A beneficial bacterium called *Lactobacillus acidophilus* is added to milk to make yogurt. In this investigation you will make your own yogurt. As you do, you will learn about the conditions that bacteria need in order to grow and reproduce.

Problem

What happens when you add *Lactobacillus acidophilus* bacteria to milk and keep the mixture warm?

Safety Precautions

- Be careful around boiling water and the hot plate.
- Clean up the work area and wash your hands thoroughly at the end of the investigation.

Apparatus

1000 mL beaker
glass stirring rod
graduated cylinder
500 mL beaker
2 beakers (100 mL)
thermometer
hot plate and wire gauze pad
oven mitts
tongs
incubator
universal pH paper or meter

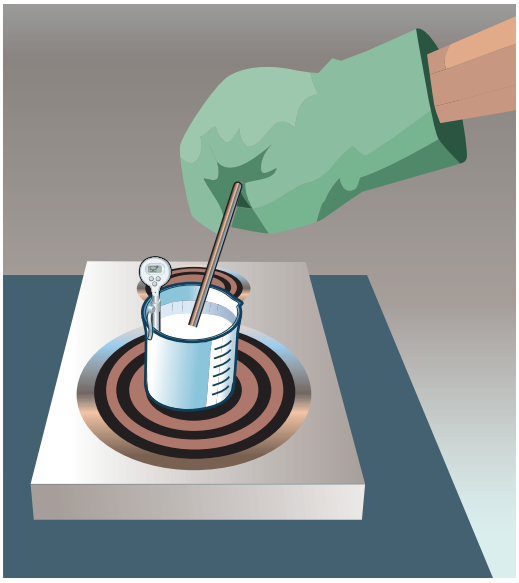
Materials

water
200 mL milk
15 mL live yogurt culture or 15 g dry *acidophilus* culture
aluminum foil
50 mL of store-bought plain yogurt

Procedure

1. Choose a partner. Wash your hands and all apparatus using soap and water.
2. Add approximately 500 mL of water to the 1000 mL beaker. Heat the water to boiling on a hot plate.
3. Sterilize the glassware for this investigation by lowering each piece, one at a time, into the boiling water. Leave them submersed for one minute each.
4. Use tongs and oven mitts to retrieve the apparatus.

5. Measure 200 mL of milk in a graduated cylinder and pour it into the 500 mL beaker. Measure an additional 100 mL of milk in a graduated cylinder and add this to the beaker.
6. Scald the milk by heating it to 85°C. Use the thermometer to check the temperature. Stir constantly with the stirring rod so the milk does not stick to the bottom of the beaker.



7. Remove the beaker from the heat. Stir the milk with the sterilized stirring rod. Continue stirring until the milk cools to 48°C.
8. Add 15 mL of live yogurt culture to the cooled milk. Stir to mix well.
9. Label two 100 mL beakers with the names of your lab group. Pour the mixture evenly into the two beakers.
10. Cover the beakers with aluminum foil and set them in the incubator for several hours or overnight. Maintain a temperature between 40°C and 45°C.
11. After it has incubated, chill the yogurt until it solidifies. Use characteristics such as thickness, texture, colour, and pH to compare your lab-made yogurt to the sample of store-bought yogurt. Remember, do not eat yogurt made in the laboratory because of the possibility it may be contaminated with other chemicals.

Disc CONNECT

What are bacteria? Where are they found? What do bacteria need to grow? How are they helpful and harmful? To answer these and other questions, load the student CD-ROM onto your computer. Launch the **Bacteria** applet and follow the instructions.

Analyze

1. Compare the yogurt you made to the plain yogurt you buy in stores. How is it the same? How is it different?
2. Why do you think it was important to wash your hands and sterilize all of the equipment before starting the investigation?

Conclude and Apply

3. Why did you heat the milk to 85°C?
4. Why did you cool the milk before adding the yogurt culture?
5. Identify the environmental conditions that are favourable to the growth of bacteria.
6. Predict what could happen if you left raw hamburger in an incubator or oven at 40°C for several hours.
7. Many types of bacteria grow all around you. Some of them are pathogens. Why should you not grow pathogens for study in the science classroom?

Internet CONNECT

www.mcgrawhill.ca/links/science.connect2
Find out more about bacteria and viruses. Go to the above web site, then to Internet Connects, Unit C, Chapter 9, and then to Bacteria and Viruses.

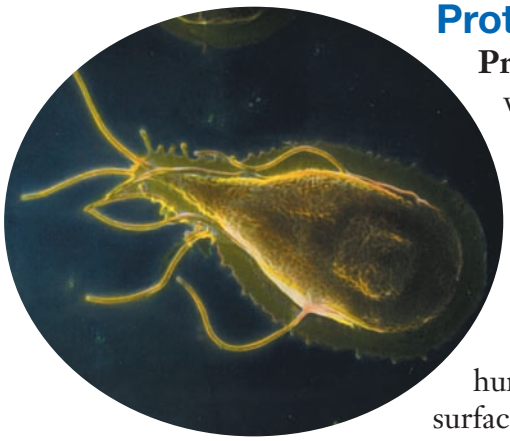


Figure 9.5 *Giardia* is the most common protist in the world. In Canada, it is also called beaver fever because beavers often carry and spread the protist.

Protists

Protists are single-celled organisms that share some characteristics with both animals and plants. Two common protists are the amoeba and the paramecium.

Some protists cause serious diseases such as malaria, African sleeping sickness, and amoebic dysentery. Malaria is spread by mosquitoes, sleeping sickness by Tsetse flies. Amoeba can be picked up from contaminated water or food.

A protist called *Giardia* lives in the intestines of infected humans or animals. *Giardia* may be found in water, food, soil, or surfaces that have been contaminated with the feces from infected humans or animals. You can become infected after you drink the contaminated water.

To prevent getting *Giardia*, drink only safe water. Since *Giardia* can also be spread on your hands, wash your hands thoroughly with soap and water after using the toilet and before handling or eating food.

READING Check

How do protists spread?

Fungi

Fungi include molds, yeasts, and mushrooms. They cannot make their own food by photosynthesis. Some fungi are **parasites** and can live only on host organisms. Fungi, such as mushrooms taste great on pizza or salad. Others cause disease. Two examples of this are athlete's foot and ringworm, two fungi that live on the body.

Figure 9.6 Athlete's foot is caused by a fungus that lives on the skin. It breeds under warm, moist conditions such as those found in sweaty socks and shoes. To prevent it, wear leather shoes and sandals so your feet can "breathe." Wear sandals or slippers in places such as change rooms with showers.

Try This!

Mix 5 mL of yeast and 5 mL of sugar in a test tube with 25 mL of warm water. Cover the top of the test tube with a balloon. Place it in a warm water bath. Watch what happens.

Key Terms

pasteurization
disease
microbes
pathogens
bacteria
viruses
fungi
protist
parasites

Check Your Understanding

1. Describe three factors that cause disease. Provide an example for each one.
2. What is a pathogen? Give three examples of pathogens.
3. Explain how viruses such as the AIDS virus spread.
4. What might happen to the bacteria in a hamburger you left on the counter for a few hours? Explain why.

9.2 Communicable and Non-communicable Diseases

You can catch a cold from a friend, but can you get diabetes from one?

The answer is no. You can catch a cold from someone because a cold is a communicable disease. Colds are caused by pathogens that can spread from one person to another.

But diabetes is a non-communicable disease. It is not caused by a pathogen. Such diseases cannot spread from person to person.

1. **Communicable diseases** — These diseases are caused by pathogens. The diseases are communicable because the pathogen carrying the disease can spread from one organism to another. The flu, the common cold, and AIDS are all examples of communicable diseases. Table 9.1 shows how such diseases spread.

2. **Non-communicable diseases** — These diseases are not caused by pathogens. As a result, they cannot be passed from one organism to another.

Interestingly, we do not know the cause of all non-communicable diseases. Today, doctors have a good idea of how people get such non-communicable diseases as diabetes, cancer, and arthritis. They are still not sure what causes depression and multiple sclerosis. But we do know one thing — people who have them do not pass them on to others.

READING Check

List the two general types of disease and explain the difference between the types.

DidYouKnow?

Typhoid Mary was a cook in New York who became famous for being a carrier of typhoid fever. She recovered from typhoid fever around 1900 but continued to carry the bacteria. Between 1900 and 1907, she infected 22 people; one died.

Doctors suspected that the victims got sick from eating food handled by Mary.

READING Check

Describe four ways in which communicable diseases can be transmitted.

Table 9.1 Communicable Diseases and Effects on Health

How Spread	Sample Disease and Type of Pathogen That Causes It	Effects of Disease
Airborne • commonly spread by coughing and sneezing • first sites of infection are the nose, throat, and lungs	(a) common cold — virus (b) influenza (flu) — virus	(a) runny nose, sore throat, cough, low-grade fever (b) fever, aches and pains, cold-like symptoms, extreme fatigue
Water-borne • contaminated water • disease often spreads through feces that contain bacteria. Feces from infected humans or animals can end up in the water system (for example, swimming pools, hot tubs, streams, ponds).	(a) dysentery — bacterium (b) *E. coli 0157* — bacterium	(a) severe cramps, diarrhea (often with blood and mucus), fever, vomiting (b) cramps, bloody diarrhea, complications such as kidney failure
Carried in Food • unsafe food handling • improper methods used to preserve food • improper storage of food	(a) **botulism** (form of food poisoning) — bacterium (b) **salmonellosis** (form of food poisoning) — bacterium	(a) double vision; difficulty speaking, breathing, and swallowing (b) fever, headache, nausea, vomiting, diarrhea
Direct Contact • direct contact with an infected person or with materials handled by an infected person	(a) meningitis — bacterium and virus (b) STDs (sexually transmitted diseases) — bacterium and virus	(a) severe headache, high fever, vomiting, neck stiffness, joint pain (b) vary according to disease but often include sores, irregular discharge, itching

DidYouKnow?

Foods containing chicken may become contaminated with bacteria if they are not handled properly. To prevent salmonellosis, chicken needs to be kept hot or cooled rapidly after it is cooked thoroughly. Chicken not eaten right away should be refrigerated.

The Importance of a Clean Environment

Diseases can be spread by air, water, food, and contact. Why aren't we all sick most of the time?

The answer has to do with our environment. Clean environments reduce the number of viruses and bacteria present. As a result, there are fewer pathogens to make us sick.

Some environments have to be super clean. There are so many pathogens associated with human feces that bathrooms have to be **sanitary**. This means maintaining clean, germ-free conditions to help prevent disease. This form of cleaning uses special cleaners such as chlorine and anti-bacterial soaps to eliminate most bacteria and viruses. Sanitary cleaning and handling practices should be used in all environments where there is a chance of high numbers of bacteria and viruses.

People who work with food must wear protective gloves when they are handling food, to avoid spreading pathogens to people who will eat the food they serve.

Another reason they need to handle food carefully is to prevent food poisoning. Food poisoning results from eating food that is infected with harmful micro-organisms. Such food can make you very ill. In some cases, it can be fatal.

READING Check

How does a clean environment protect you from disease?

Find Out ACTIVITY

Disease Wanted — Dead or Alive!

In 2001, some American postal workers died from anthrax, a bacteria they picked up while sorting mail. People across Canada and the United States started to worry about biological terrorism.

Biological terrorism uses pathogens to threaten or harm people. How safe are we from such terrorism? This activity will help you decide.

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

What to Do

1. Work in a group of four. Have each group member choose *one* of the following pathogens to research: anthrax, smallpox, cholera, plague, botulism, Ebola, meningitis. Use reference books or the Internet to answer the following questions.
   - How common is the pathogen?
   - Who is allowed to have live samples of the pathogen?
   - How is the disease transmitted?
   - What is the treatment?
   - How serious is the threat of this pathogen being used for biological terrorism?
   - What can the government and individuals do to prepare for a terrorist attack?
2. Prepare to present your findings.

What Did You Find Out?

1. What is the likelihood of someone making biological weapons? Explain your answer.
2. Develop a short oral presentation about one of the biological weapons you researched.
3. What can governments and citizens do to prepare for a terrorist attack with biological weapons?
4. Use assessment material provided by your teacher to help you. Evaluate the quality of the information you found.

How Do You Get a Non-communicable Disease?

Communicable diseases are caused by bacteria and viruses spread by air, water, food, and contact. How do people get non-communicable diseases?

Many non-communicable diseases are the result of bad environmental conditions, poor diets, unhealthy lifestyles, and genetics.

Check the figures that follow to see how each of these can result in disease.

READING Check

List four factors that affect the risk of developing a non-communicable disease.

Figure 9.7 Where do you find the most polluted air? Whether or not you smoke, it is probably in your home. This is because it is difficult to circulate fresh air inside a building. Exposure to polluted air (from cigarettes, for example) causes diseases such as emphysema. Emphysema is a lung condition in which breathing becomes more and more difficult.

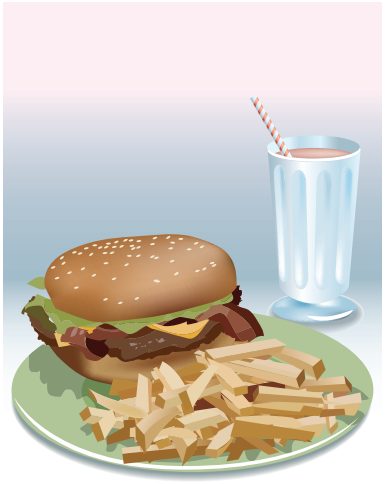


Figure 9.8 If you eat this meal once in a while, don't worry! If you eat this way regularly, however, you have a poor diet. People with poor diets often suffer from high levels of sickness. For example, a diet high in fat and cholesterol may cause heart disease. In heart disease, blood flow to the arteries supplying the heart becomes more and more restricted.

Figure 9.9 Screen time may be important to you. But you need to balance the amount of down time with active exercise. Lack of exercise can result in obesity. People who are 10 percent over the ideal body weight for their height and bone structure are obese. Being obese strains your heart's ability to function and increases your chances of developing Type II diabetes.

Figure 9.10 Genetics refers to the characteristics you inherit from your birth parents. Genetic factors are associated with diseases such as cystic fibrosis (CF), which damages the respiratory and digestive systems. Exercise may benefit people with CF by improving their strength and endurance.

DidYouKnow?

Every day, 1.5 million children in Canada go to school hungry. Malnourished children are more likely to get sick.

Check Your Understanding

1. Define "communicable disease." List three examples.
2. Define "non-communicable disease." List three examples.
3. Make a table with three columns.
   - In the first column, list at least five diseases you or your family members have or have had.
   - In the second column, identify each disease as communicable or non-communicable.
   - In the third column, list the effects of each disease on health.

Key Terms

communicable
non-communicable
botulism
salmonellosis
sanitary

9.3 Who Is Most Likely to Get Sick?

READING Check

How does poverty contribute to the spread of disease?

In Canada, the average female can expect to live 81 years. The average male will likely see his 75th birthday. In Sierra Leone, an African country, the average female will live only 35 years and the average male 33 years. The difference has to do with living conditions.

Canada is a wealthy country. Most Canadians have enough food, clean water to drink, air that is relatively unpolluted, proper health care, and access to public education. The majority of adult Canadians also have paying jobs.

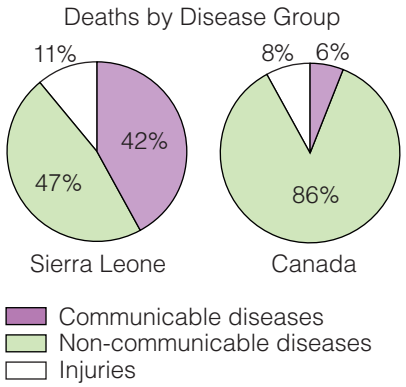


Figure 9.11 What fraction of people in Sierra Leone die from communicable diseases? How does that compare to the number of people in Canada who die from such diseases?

People in Sierra Leone have access to few or none of these things. In short, they live in **poverty**. This means that their basic needs for food, water, health care, and education are not met.

Children born in poor countries often die of starvation because they do not get enough to eat. They are also more likely to get a communicable disease. Because there is little health care, they often die from such illnesses.

Those who do survive to adulthood continue to be more likely to get a communicable disease. In Canada, pollution-control plants purify drinking water. In poor countries, drinking water comes directly from streams and rivers, which may be full of bacteria, viruses, and parasites.

DidYouKnow?

Review the following worldwide statistics about people high risk for disease. Do you think that such living conditions are acceptable? If not, what can you do to help?

- More than one billion people lack clean water.
- More than two billion people lack toilets.
- Every year, nearly a billion people suffer from illnesses caused by contaminated water. The young and the elderly are the most at risk.
- Over half of the children that die every year die from malnutrition.

What Are Your Risk Factors?

No matter where you live, the same risk factors increase your chance of getting sick:

- not eating properly,
- drinking unclean water,
- not having a toilet,
- not practising personal hygiene, such as washing hands frequently,
- having sex,
- smoking tobacco, and
- consuming alcohol.

Which of these risk factors do you have? Look at Table 9.2 to see some of the diseases you *might* get.

Table 9.2 Risk Factors and Disease

Risk Factor	Possible Disease	Source of Risk
not eating properly	obesity, diabetes, heart disease, cancer, tuberculosis	economic, social
drinking unclean water	diarrhea, parasites, *E. coli*	economic
not having a toilet	diarrhea, tuberculosis, parasites	economic
not practising personal hygiene such as washing hands frequently	tuberculosis, food poisoning	economic, social
having sex	AIDS and STDs	social
smoking tobacco	emphysema, bronchitis, and other respiratory conditions; arteriosclerosis and other circulatory diseases; cancer	social
consuming excess alcohol	liver disease, dementia, malnutrition	social

Figure 9.12 Natural disasters, like this flood and ice damage in Badger, Newfoundland, in 2003, can result in sanitation problems. Septic systems may overload. Once the ice thaws, water run-off provides breeding grounds for bacteria and viruses. As a result, victims may have limited access to clean water. Large numbers of injured people may overload medical facilities. People may get infections from the unsanitary conditions.

In poor countries, all of these problems are worse. In addition, food supplies may not be handled or stored properly. As a result, they may become contaminated.

DidYouKnow?

During the 1930s, the Canadian Prairies suffered an eight-year drought that ruined farmland and stirred up gigantic dust storms. People died of starvation and lung diseases caused by breathing in the dust.

Check Your Understanding

1. What is poverty?
2. Use Table 9.2 to identify what diseases you may be at risk of getting. Explain how you could reduce your risk of getting each one.
3. Defend the statement, "Access to safe water reflects the health of a country's people."
4. What type of disease kills most people in poor countries? in rich countries? Explain why you think this is so.

Key Terms

poverty

9.4 Stop Disease in Its Tracks

DidYouKnow?

Each year, there are a few cases of a form of food poisoning called botulism. The bacterium that causes botulism has the ability to grow in the absence of air and produce the deadliest toxin known. The death rate is high if it is not treated immediately. Botulism comes from Latin word *botulus*, which means sausage. Also known as Kerner's Disease, it was named after the man who signed death certificates of people who ate contaminated sausage and died in an outbreak in Germany.

Today, dentists, first-aid volunteers, and even fast-food servers wear rubber gloves to protect themselves — and you — from disease.

Preventing Food Poisoning

The *staphylococcus* bacteria or **staph bacteria** that cause food poisoning enter food when you cough, sneeze, or handle food without washing your hands properly. Rubber gloves prevent some of the spread of these bacteria. Careful cleaning of the cooking utensils and area also help. Change dishcloths daily — bacteria can grow in used dishcloths. Do not use sponges, which provide great breeding grounds for bacteria.

Food poisoning can also be caused by food that is not preserved well. Read the next section to learn about different preservation methods.

READING Check

Choose three different methods of food preservation. Explain how each one prevents food poisoning.

Food Preservation

Preserving food prevents or limits the growth of pathogens that cause food poisoning. Table 9.3 explains how each method of food preservation helps prevent or limit this growth.

Identify each of the modern methods in Table 9.3 and read about how it works.

Table 9.3 Methods of Food Preservation

Method	Process and Effect on Decomposers
smoking or drying food	• Removes moisture so that pathogens cannot grow.
canning	• Jars filled with food are boiled in a hot water bath to kill existing pathogens.
salting	• Removes moisture from cells and makes pH inhospitable for bacteria growth.
refrigeration	• Bacteria need warm temperatures in order to live and reproduce. Refrigeration slows down the growth of pathogens.
freezing	• Freezing causes bacteria to enter a dormant stage. • It also prevents the growth of pathogens.
chemical additives	• Additives such as sugar and salt slow the growth of bacteria.
vacuum packaging	• Bacteria need air in order to survive. Vacuum packaging removes air from the package. This reduces the number of bacteria that spoil food. • Unfortunately, some botulism bacteria like low-oxygen environments. They reproduce well in foods packaged this way, and can cause food poisoning.
irradiation	• Food is exposed to certain types of radiation energy. This destroys pathogens in meat, fish, and poultry.
pasteurization	• Bacteria cannot survive in extremely high temperatures. Pasteurization involves heating a liquid such as milk to a high temperature for a specific period of time. The liquid is then cooled rapidly and refrigerated. • It destroys harmful bacteria without changing the flavour or nutritional value of the food.

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Let's Go on a Picnic!

Consider the foods that have to be kept in a refrigerator. List 10 or more food products that need to be refrigerated to slow down the rate of food spoilage.

Think About It

Use what you have learned about safe food handling practices to plan a picnic for friends on a hot, sunny day.

What to Do

1. Use a chart to organize the following information.
   - In the first column, list each of the foods on the menu: chicken wraps, coleslaw, home-canned black bean salsa, coconut cream pie, lemonade, fresh strawberries.
   - In the second column, describe how it should be prepared.
   - In the third column, describe how it should be kept safe from contamination.
   - In the fourth column, identify what form of food poisoning might occur if it is handled improperly.

Analyze

1. **(a)** If the canned salsa is two years old and the seal is broken, what type of illness might the picnickers get?

   (b) What would the symptoms be?

2. What advice would you give to a friend who wanted to eat potato salad left on a picnic table for several hours? Why?

Extend Your Skills

3. Describe your favourite meal. For each food, list the steps you need to follow to keep it safe to eat. Include steps during and after preparation.
4. The picnickers decide to help clean up. If there is a choice between dishcloths and paper towels, which would you recommend using? Explain why.

DidYouKnow?

The glass dome over the salad bar is actually a sneeze guard to keep bacteria out of salads.

Figure 9.13

Figure 9.14 Florence Nightingale

Keeping Hospitals Healthy

Two hundred years ago, people expected to die when they went to the hospital. Hospitals were so unsanitary that patients often picked up diseases in the hospital. Today, this is less common because of the work of scientists such as Florence Nightingale, Joseph Lister, and Robert Koch.

In the 1800s, Florence Nightingale worked in a military hospital in Turkey. She reduced the death rate by making sure the hospital and patients were kept clean, improving water quality, and bandaging wounds to prevent infections from spreading to other patients.

Around the same time, an English surgeon named Joseph Lister realized that many patients died of infections following surgery. He began spraying carbolic acid on patient wounds and into the air of operating theatres. Carbolic acid kills pathogens on surfaces and on skin.

Robert Koch discovered that hot steam was effective in killing pathogens. He began using steam to destroy living organisms. This process is called **sterilization**.

READING Check

What is the purpose of sterilization?

Aseptic Methods

Modern medicine uses many techniques to keep hospital rooms and equipment **aseptic** or free of pathogens. Aseptic practices include:

- using sterile bandages, instruments, linens, masks, and clothing during surgery;
- scrubbing all exposed skin of the surgeon before and after surgery; and
- having all surgical staff wear rubber gloves to prevent the spread of pathogens that might hide under fingernails.

In addition, antiseptics are used on people to disinfect the skin. Such antiseptics include iodine solution and alcohol.

Disinfectants are used on objects and surfaces to sterilize them. Some common disinfectants include iodine, chlorine, bleach, and antibacterial soaps.

Try This!

Read labels on soaps, shampoos, body washes, and toothpastes. Triclosin is a disinfectant commonly used in these products. Find and list some products it is used in.

Try This!

Take a sample of water from a stream or ditch. Observe it under a microscope. Note any signs of life. Add a drop of bleach to the slide. Observe any changes. Repeat this activity using other antiseptics and disinfectants.

DidYouKnow?

Hospitals in the Middle East were among the first to recognize the importance of sanitation. By the 1100s, hospitals in Baghdad and Cairo contained fountains where patients could wash themselves. Washing facilities for patients did not appear in Europe until much later. In fact, many early surgeons performed operations without even washing their hands.

DESIGN & DO

INVESTIGATION 9–C

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Do Antiseptics and Disinfectants Kill Microbes?

Advertisers promote many different antiseptics and disinfectants. Do their products really kill microbes?

Challenge

Design an investigation to determine how well different products destroy microbes.

Safety Precautions

- Use caution when handling products. Some may be irritating to the skin.
- Do not swallow any product. They are harmful if swallowed.
- Use caution when handling bleach. It can cause skin irritations and stain clothing. Do not inhale the vapours.
- Be careful to dispose of materials properly.
- Clean up any spills immediately.
- Clean up the work area and wash your hands thoroughly at the end of the investigation.

Design Criteria

A. Choose which antiseptics and disinfectants you will use. Consider toothpaste, mouthwash, hydrogen peroxide, rubbing alcohol, bleach, antibacterial soap, and baking soda.

B. Use yeast to represent microbes. Yeast lives in similar environments to bacteria and viruses.

C. Decide how to use methylene blue to check for the effectiveness of an antiseptic or disinfectant. In the presence of living cells, methylene blue does not penetrate cell membranes. As a result, the cells remain clear. It *does* invade dead cells. The cells appear blue under a microscope.

D. Develop:
- a problem statement;
- a list of apparatus, materials, and safety precautions; and
- a detailed procedure, including evaluation criteria.

Plan and Construct

1. Write out the problem you will investigate.
2. With a partner, discuss and decide on the following.
   - **(a)** How much yeast solution will you use for each test?
   - **(b)** What control will you use? For example, how will you show that it is the product that is destroying microbes?
   - **(c)** How will you mix the yeast solution and product?
   - **(d)** How will you check whether or not the yeast has been killed?
   - **(e)** How long will you leave the yeast solution in each product?
3. Use the worksheet provided by your teacher to help you develop a procedure for and evaluate this investigation. Get your teacher's approval before doing the investigation.

Check Your Understanding

1. Explain how each of the following methods of food preservation protects food from pathogens: vacuum packaging, canning, freezing, and drying.
2. List five recommendations for protecting food preparation surfaces and utensils from contamination.
3. Explain why you would put an antiseptic and a disinfectant in a first-aid kit.

Key Terms

staph bacteria
sterilization
aseptic

CHAPTER 9

Review

Key Terms

pasteurization
disease
microbes
pathogens
bacteria
viruses
fungi
protist
parasites
communicable
non-communicable
botulism
salmonellosis
sanitary
poverty
staph bacteria
sterilization
aseptic

Reviewing Key Terms

If you need to review, the section numbers show where these terms were introduced.

1. In your notebook, write the key term that corresponds to each of the following clues.

(a) diseases caused by pathogens (9.2)

(b) illness that results from the deadliest toxin known (9.2)

(c) process that destroys harmful bacteria in foods such as milk (9.1)

(d) any condition that prevents normal body function (9.1)

(e) these enter food when you handle it without washing your hands properly (9.4)

(f) illness caused by eating undercooked meat (9.2)

(g) kind of disease usually not caused by pathogens or transmitted by direct contact with an infected individual (9.2)

(h) free from dirt and pathogens (9.2)

(i) general term for disease-causing organisms (9.1)

(j) situation in which people's basic needs are not met, which may increase chances for spread of disease (9.3)

(k) process of destroying pathogenic organisms (9.4)

(l) free from pathogens (9.4)

(m) four examples of pathogens (9.1)

Understanding Key Ideas

Section numbers are provided if you need to review.

2. Explain what a protist is. Provide two examples. (9.1)

3. List three factors that cause disease. (9.1)

4. What conditions do bacteria need in order to grow? (9.1)

5. Explain how water and food can transmit disease. (9.2)

6. Explain how ill health may result from poor lifestyle choices. (9.2)

7. How does poverty affect health? (9.3)

8. Use an example to explain how preserving food prevents food poisoning. (9.4)

9. (a) What is the purpose of using aseptic techniques?
(b) Identify three aseptic practices used by health-care providers. (9.4)

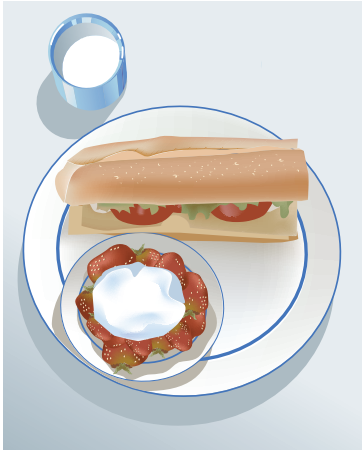
Developing Skills

10. Think about a time when you were ill with a communicable disease. Explain how you might have received the pathogen that made you sick. (9.2)

11. Defend the statement, "Natural disasters can negatively affect health." (9.2, 9.3)

Problem Solving/Applying

12. Sometimes commercial yogurt is pasteurized. Is it possible to use pasteurized yogurt as a starter to make more yogurt? Explain why or why not. (9.1)



13. Develop and use a chart to explain how you would prepare and store each food shown in the meal here. The meal includes a sub sandwich with salami, cheese, mayonnaise, lettuce, and tomato; a glass of milk; and a bowl of strawberries and whipped cream. (9.4)

In your chart, include

- the name of each food,
- how it should be prepared,
- how to protect it from bacterial growth, and
- why these precautions work.

14. In good conditions, bacteria can double their numbers every 20 minutes. The table shown here shows how quickly they can multiply. (9.4)

(a) Copy the table into your notebook and fill in the missing values.

Time (in minutes)	Number of Bacteria
20	1 million
40	2 million
60	4 million
80	?
100	?

Computer CONNECT

Use a spreadsheet to generate a graph of the data for question 14.

(b) Create and label a graph showing the rate of growth of bacteria.

(c) Extend the graph to show the growth of bacteria over six hours.

(d) What might you conclude about bacteria in food left out on a banquet table?

Critical Thinking

15. How is breakfast cereal packaged to reduce the growth of bacteria? Explain how this works. (9.4)

16. How do people travelling from one country or region to another affect the spread of disease? (9.1, 9.2, 9.3)

Extend Your Understanding

17. Collect at least two articles about non-communicable diseases and their effects on health in Canada. Read each article and identify the main point. Present your findings in a brief oral presentation. (9.2)

Pause & Reflect

1. Check your original answers to the Getting Ready questions on page 156. How has your thinking changed? How would you answer these questions now that you have investigated the topics in this chapter?
2. What lifestyle changes are you prepared to make to protect your health?